DC:

PARALLEL CIRCUITS Troubleshooting

Unclassified:

2 Hour Conference W/2Hr. PE1

afety & Environmental
npact: “LOW”

Terminal learning Objective.

ACTION: Locate a malfunction in a parallel circuit.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130A electronics trainer, digital Multimeter w/test leads, PC-130-8A and PC-130-8B circuit cards, schematic diagrams, calculator and official OMEMS references.

STANDARDS: Be able to locate and identify an open, short, or changed value malfunction within a parallel circuit using proper procedures to the established standard of 7 correct answers out of 10 & 8 out of 10 for EOD.

Introduction

Parallel circuits concepts and calculating for the normal operating parameters covered in the previous lesson will have direct application in trouble shooting. The normals will be the point of reference that will be used to compare a Ckt that is suspected to be malfunctioning. Close observation & direct application of the rules & concepts is fundamental.

The procedure & breakdown is the core of this lesson, this will enable the aspiring technician to successfully diagnose & locate a malfunction based on the symptoms.

VOLTAGE

DC: Parallel Circuits Troubleshooting

Rules & Concepts: Voltage.

VOLTAGE; Is constant or the same, $E_{R1} = E_{R2} = E_{R3} = EA$.

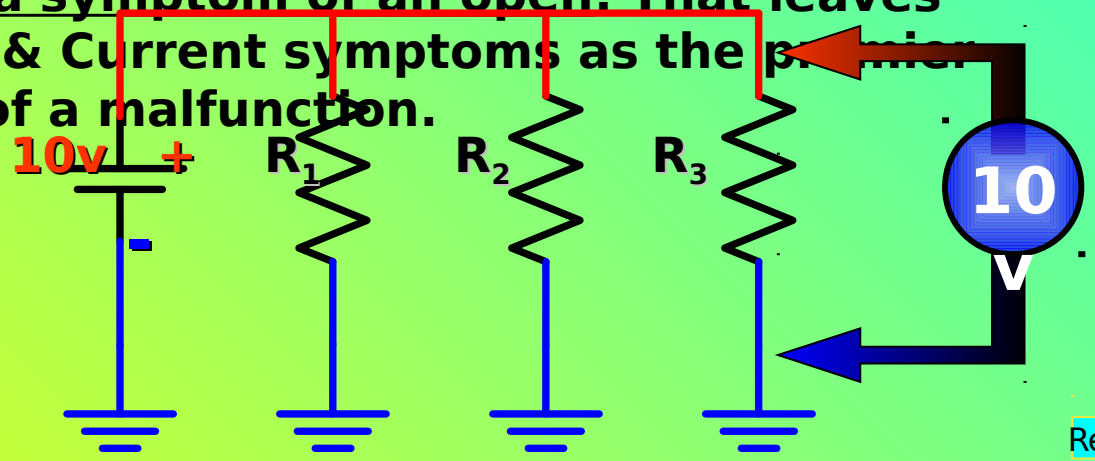
E_{REQ} is the Voltage Drop of the parallel Ckt.

EA & E_{REQ} are the same in a PURE Parallel Ckt.

Because the Voltage Drops of a Parallel Ckt are the same on each Resistor, it is impractical to use Voltage as a symptom of an open. That leaves Resistance & Current symptoms as the primer indicators of a malfunction.

Note:

All points north & south on each of the Resistors are the same electrically as the Battery.



Resistance

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Rules & Concepts; Resistance.

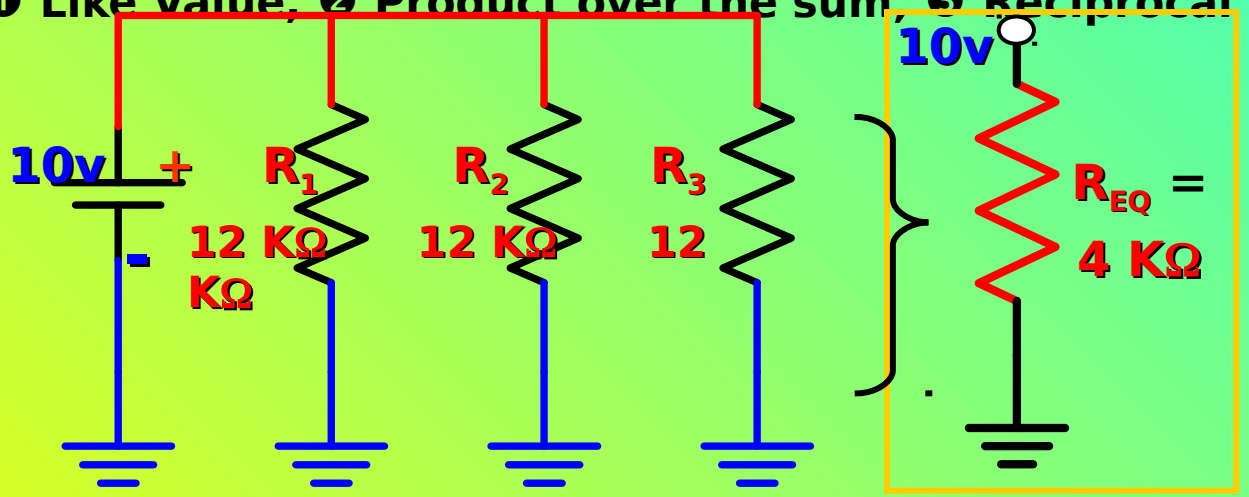
Because there is more than one path for Current flow, Resistance has to be calculated using a Resistance Equivalency Quotient, or simply the REQ.

The REQ effectively reduces the parallel portion down to a singular value of resistance.

The REQ will always be smaller than the smallest resistor in the Ckt.

3 Methods of calculating;

❶ Like Value, ❷ Product over the sum, ❸ Reciprocal [1/X].



Current

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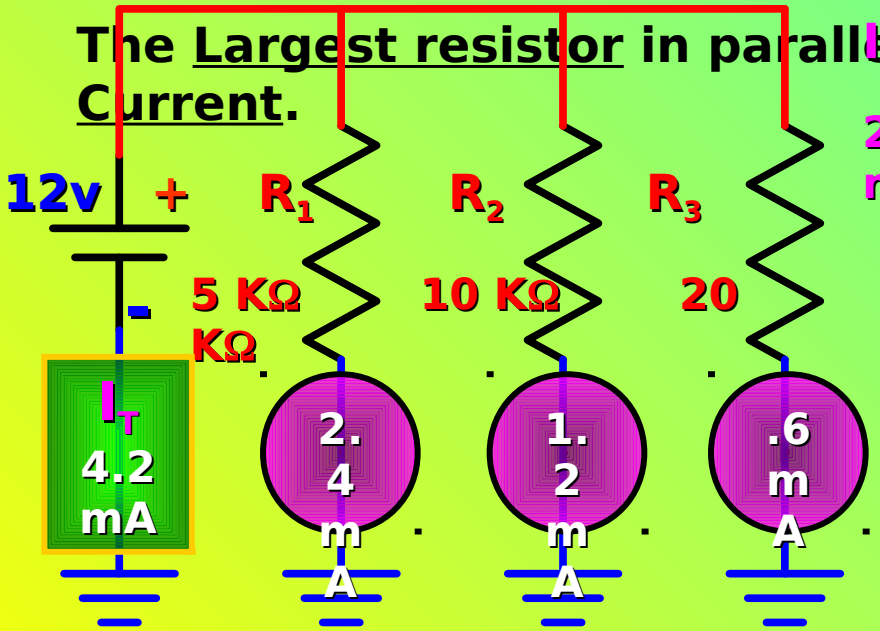
Rules & Concepts; Current.

Current is Additive to = I_T or, the sum of the Branch Currents is = to I_T.

Mathematically expressed; $I_{R1} + I_{R2} + I_{R3} = I_T$.

The Smallest resistor in parallel will conduct the most Current.

The Largest resistor in parallel will conduct the least Current.



$I_{R1} + I_{R2} + I_{R3} = I_T$

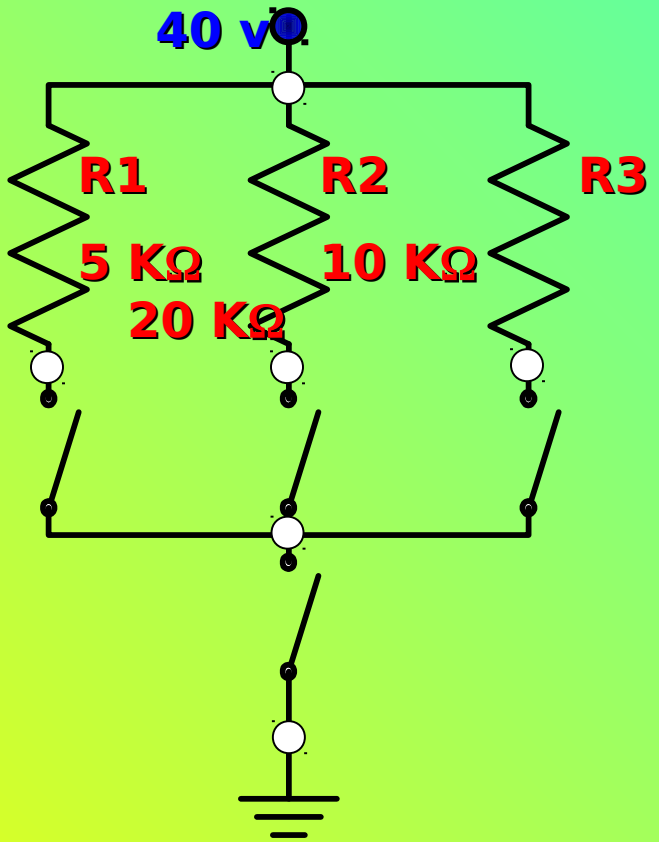
2.4 mA + 1.2 mA + .6 mA = 4.2 mA

* Current is Always measured across an OPEN switch [Ckt].

Challenge

DC: Parallel Circuits Troubleshooting

Calculate for the normal operating parameters.



E_A = _____

R_{EQ} = _____

I_T = _____

I_{R1} = _____

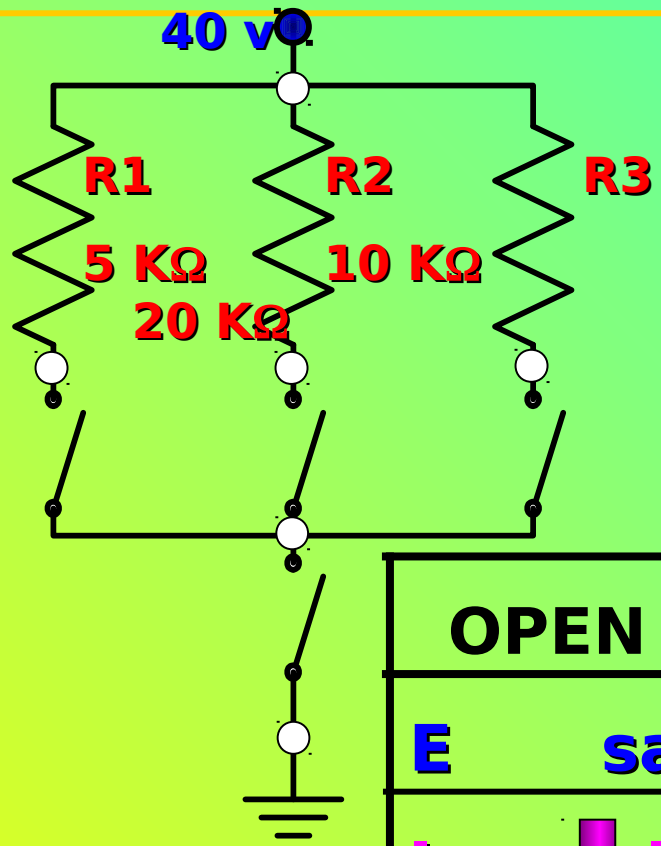
I_{R2} = _____

I_{R3} = _____

Answers

DC: Parallel Circuits Troubleshooting

The normal operating parameters are a point of reference.



E_A = 40 v

R_{EQ} = 2.857 KΩ

I_T = 14 mA

I_{R1} = 8 mA

I_{R2} = 4 mA

I_{R3} = 2 mA

OPEN	SHORT
E same	↓ = 0v
I ↓ IT & IR#	↑ = Max
R ↑ REQ	↓ =

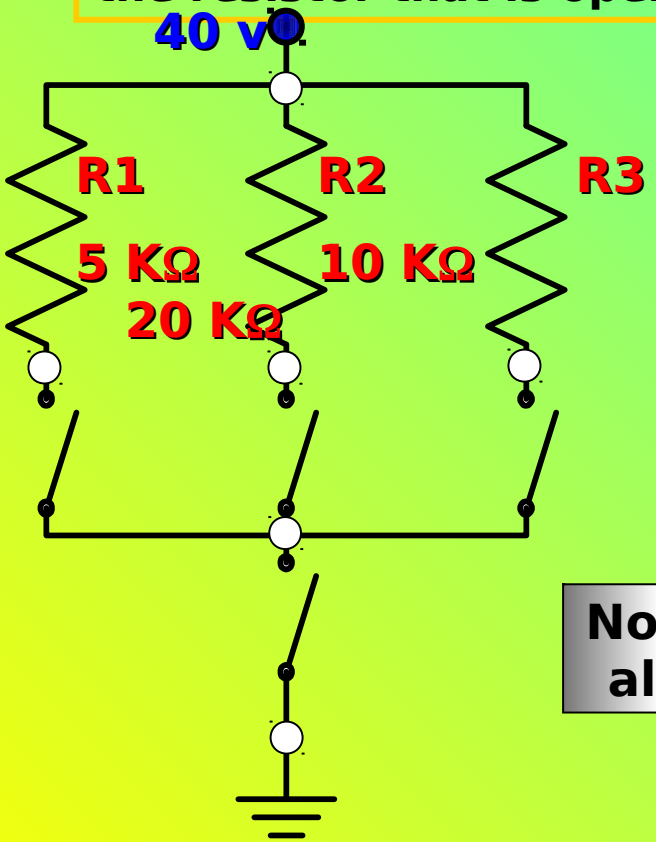
0 Ω

Trouble Shoot Opens

DC: Parallel Circuits T/ S, OPENS

Using the R_{EQ} & I_T to reveal the OPEN Branch in Parallel .

REQ Method: Take EA, Divide by the symptom REQ to = Symptom I_T, Find the Difference between the normal I_T & symptom I_T. The difference Is the Branch Current for the resistor that is open.



Symptoms:

E_A = 40 v

R_{EQ} = 3.33 KΩ

I_T = 12 mA

Normals:

E_A = 40 v

R_{EQ} = 2.857 KΩ

I_T = 14 mA

I_{R1} = 8 mA

I_{R2} = 4 mA

I_{R3} = 2 mA

40 ÷ 3.33 KΩ = 12 mA

14 mA – 12mA = 2mA

Normal I_T

Symptom I_T

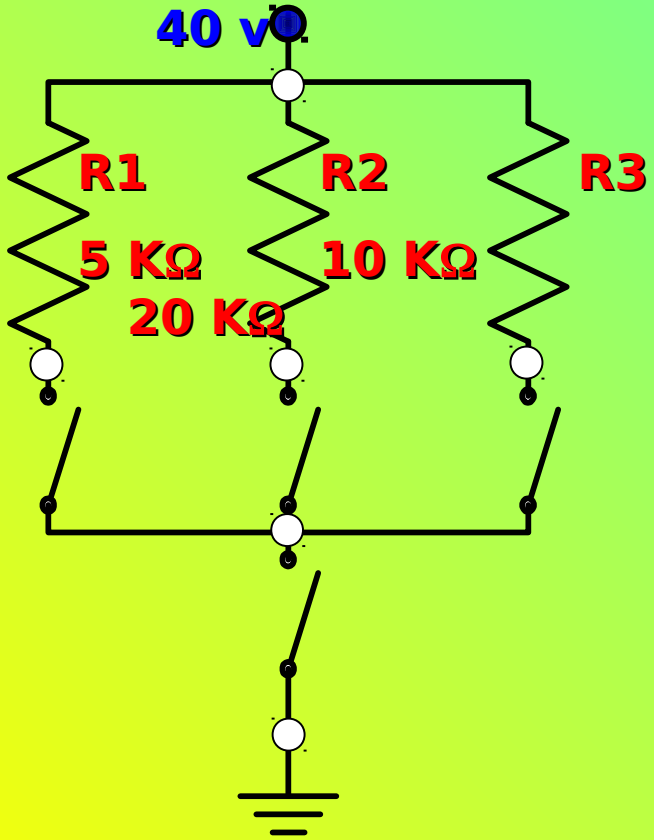
Open R3

Challenge

DC: Parallel Circuits T/ S, OPENS

Using the R_{EQ} & I_T to reveal the OPEN Branch in Parallel.

Calculate for Symptom I_T & Reveal the malfunctioning resistor, Given Symptom R_{EQ} .



Symptoms:

E_A = 40 v

R_{EQ} = 6.66 KΩ ↑

I_T = ? mA ↓

Symptoms:

E_A = 40 v

R_{EQ} = 4 KΩ ↑

I_T = ? mA ↓

Normals:

E_A = 40 v

R_{EQ} = 2.857 KΩ

I_T = 14 mA

I_{R1} = 8 mA

I_{R2} = 4 mA

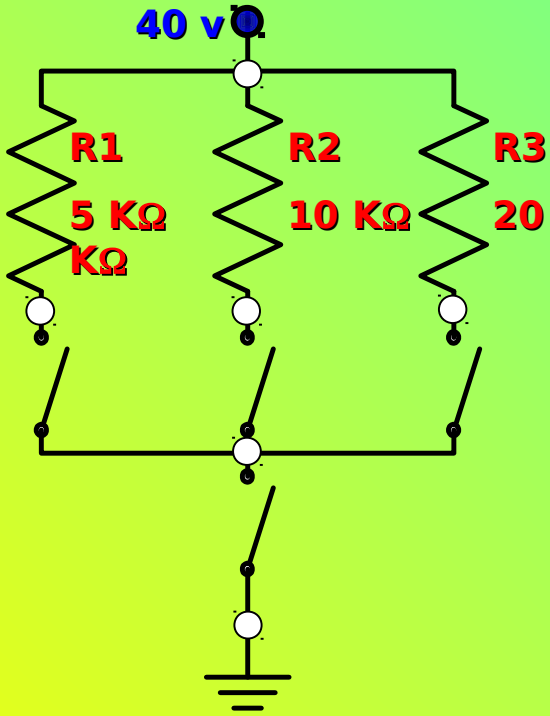
I_{R3} = 2 mA

Answers

DC: Parallel Circuits T/ S, OPENS

Using the R_{EQ} & I_T to reveal an OPEN in Parallel .

Calculate for Symptom I_T & Reveal the malfunctioning resistor, Given Symptom R_{EQ} .



Symptoms:

E_A = 40 v

R_{EQ} = 6.66 KΩ

I_T = 6 mA

14 mA – 6 mA = 8mA

Normals:

E_A = 40 v

R_{EQ} = 2.857 KΩ

I_T = 14 mA

I_{R1} = 8 mA

I_{R2} = 4 mA

I_{R3} = 2 mA

Symptoms:

E_A = 40 v

R_{EQ} = 4 KΩ

I_T = 10 mA

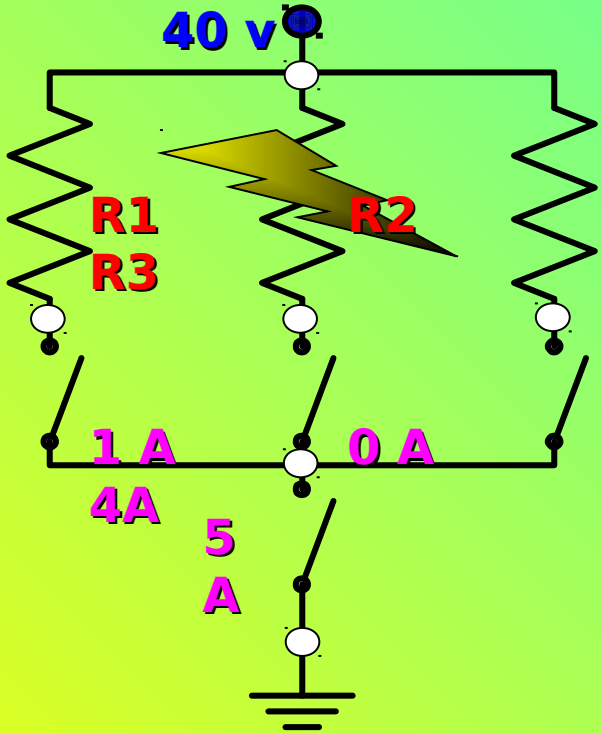
14 mA – 10 mA = 4 mA

Troubleshoot, Branch Current

DC: Parallel Circuits T/ S, OPENS

Using $I_{R\#}$ to reveal an OPEN in Parallel .

If a Branch Resistor is Open, the current flow in that Branch ceases, $I_{R\#}$ will = 0 Amps & I_T will ⇓by the amount that the open Branch would normally conduct.



Normal Current:

$I_{R1} + I_{R2} + I_{R3} = I_T$

1 A + 2 A + 4 A = 7 A

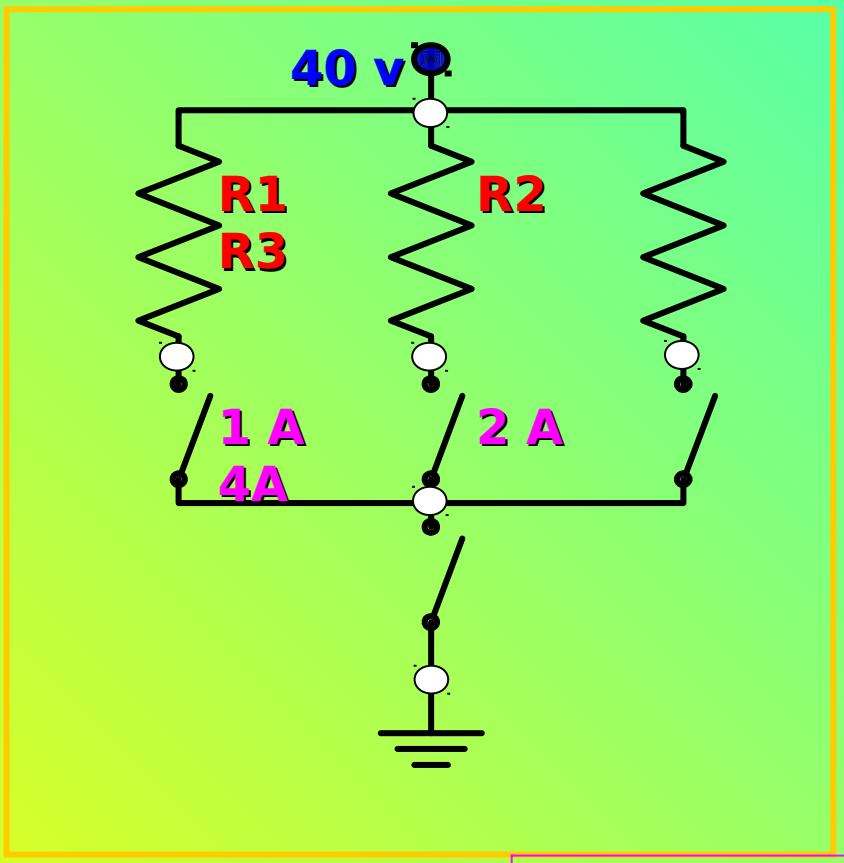
Symptom Current: $I_{R1} + I_{R3} = I_T$

1 A + 4 A = 5 A

Challenge

DC: Parallel Circuits T/ S, OPENS

<u>Calculate for the unknown</u> operating parameters of Ckt. Branch Current & EA is Given.



E_A = 40 v

R_1 = ?

R_2 = ?

R_3 = ?

R_{EQ} = ?

I_T = ?

I_{R1} = 1 A

I_{R2} = 2 A

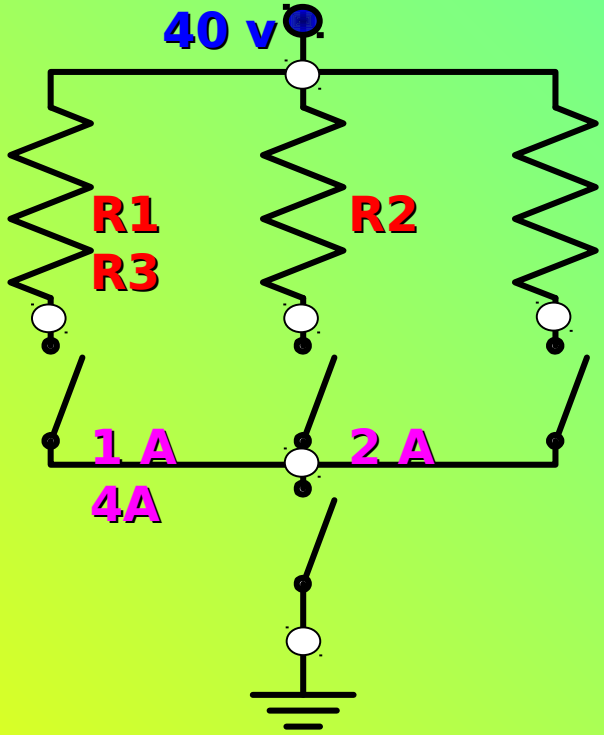
I_{R3} = 4 A

Hint: use Ohms & Kirchhoff's Laws.

Answers

DC: Parallel Circuits T/ S, OPENS

Calculate for the unknown operating parameters of Ckt. Branch Current & EA is Given.



E_A = 40 v

R_1 = 40 Ω

R_2 = 20 Ω

R_3 = 10 Ω

R_{EQ} = 5.71 Ω

I_T = 7 A

I_{R1} = 1 A

I_{R2} = 2 A

I_{R3} = 4 A

$E_A \div I_{R1} = R_1$

$E_A \div I_{R2} = R_2$

$E_A \div I_{R3} = R_3$

3

$E_A \div I_T = R_{EQ}$

2

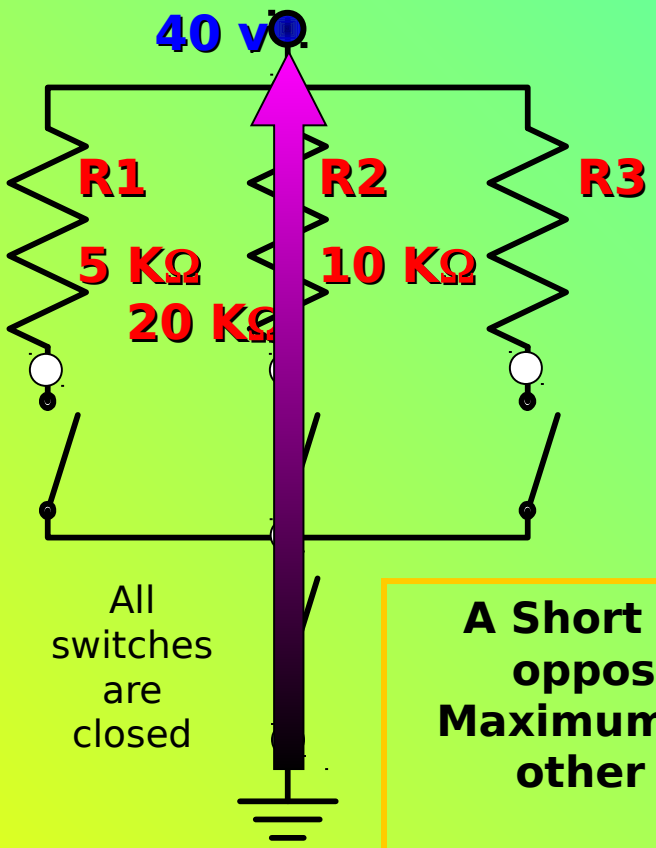
Sum of the Branch Currents = IT

1

Shorts

DC: Parallel Circuits T/ S, SHORTS

Any SHORT in parallel, shorts the entire parallel Ckt.



SHORT	
E ↓	= 0v
I ↑	= Max
R ↓	= 0 Ω REQ & R2

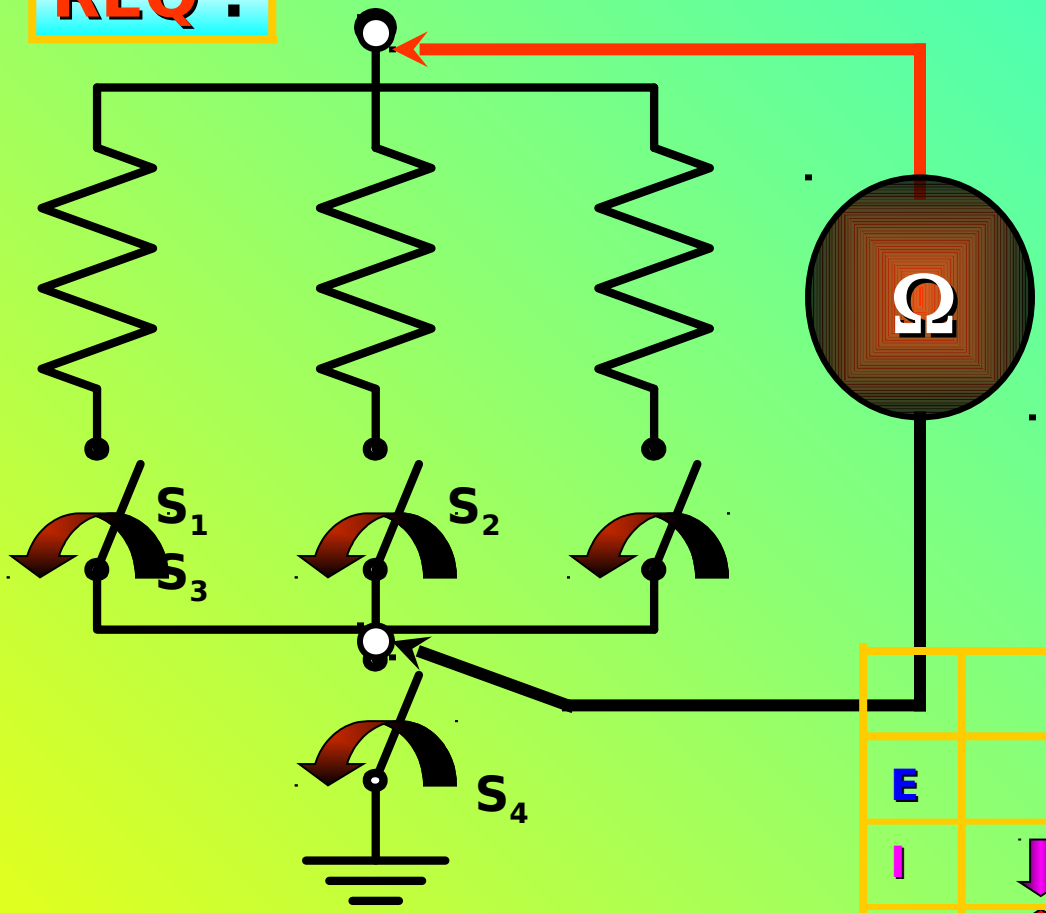
A Short Is an extreme condition, there is no opposition to current flow. Current is at Maximum to the extent of heat & over driving other components outside of the Ckt to malfunction.

Current always takes the path of least Resistance.

Measurements; REQ

DC: Parallel Circuits T/ S, Measurem

REQ :



POWER: OFF

METER:
Ohms

$S_{1, 2, 3, 4}$: CLOSED

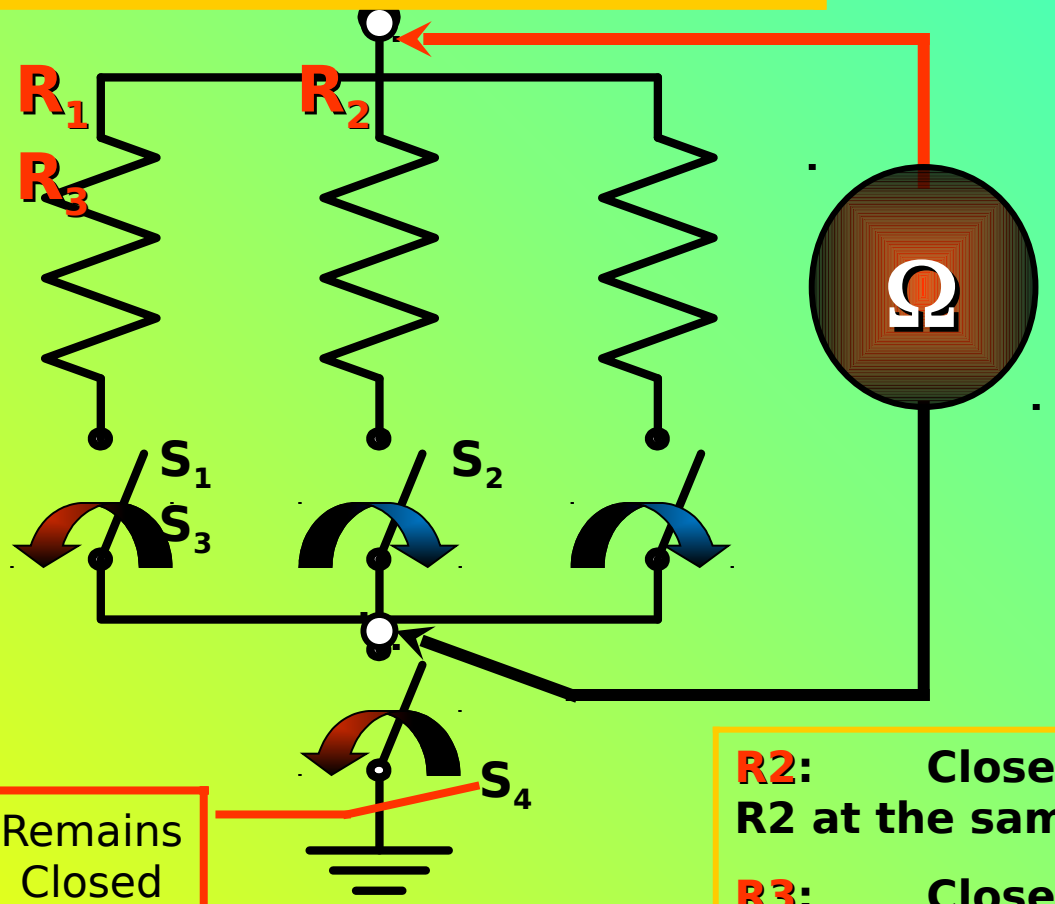
LEADS:
Bracket the entire Parallel Ckt, between the Red & Black leads.

	OPEN	SHORT
E	same	↓ = 0v
I	↓ IT & IR#	↑ = Max
R	↑ REQ	↓ = 0 Ω

8A Ckt Card, REQ

DC: Parallel Circuits T/ S, Measurem

Branch Resistors: R1, 2, 3



POWER: OFF

METER:
Ohms

Isolate the resistor

S1 & 4: CLOSED

S2 & 3: Open

LEADS:
Bracket R1 between the Red & Black leads.

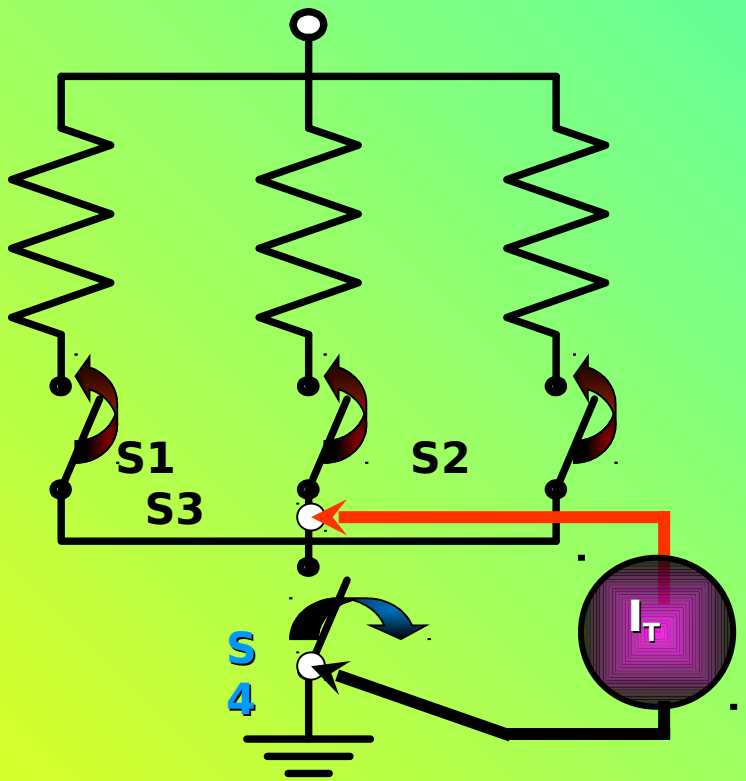
R2: **Close S2, open S1, Bracket R2 at the same Test Points as R1.**

R3: **Close S3, open S2, Bracket R3 at the same Test Points as R**

8A Ckt Card, Resistance, R1

DC: Parallel Circuits T/S Measurements

Total Current, I_T



POWER: ON

METER: CURRENT

Switches: S1, 2, 3: CLOSED

S4: Open

LEADS: Bracket S4 between the Red & Black leads.

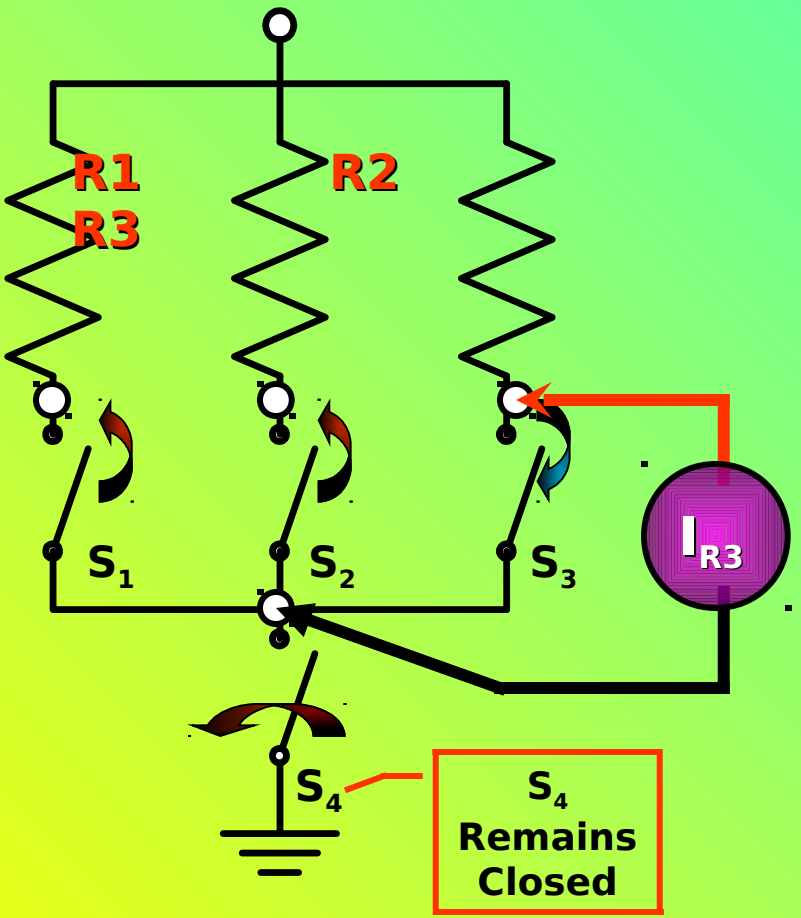
Current is always Measured across an open switch [Ckt] !

	OPEN	SHORT
E	same	↓ = 0v
I	↓ IT & IR#	↑ = Max
R	↑ REQ	↓ = 0 Ω

8A Ckt Card, IT

DC: Parallel Circuits T/ S, Measurem

Branch Current, I_{R3}



METER:
CURRENT

Switches: S1, 2, 4:
CLOSED

S3: Open

LEADS: Bracket S3 between the Red & Black leads.

By taking the measurement across an open switch, current is given a path thru the meter.

The switch in the branch that the measurement is being taken must be Bracketed W/Red lead & opened, all others must be closed.

S_1 opened for I_{R1}

S_2 opened for I_{R2}

8A Ckt Card, Branch IR3

DC: Parallel Circuits Troubleshooting

Lesson Test:

Standard: **10 Questions W/in 20 minutes** **70% Minimum Accuracy.**

80 % for EOD.

Reference: **Official OMEMS Training Aids**